Lawrence Berkeley National Laboratory

JAMES E. HOUSEWORTH, Ph.D.
Program Manager

Education:

Ph.D.,1984, Environmental Engineering Science, California Institute of Technology
M.S.,1978, Environmental Engineering Science, California Institute of Technology
B.S.,1977, Environmental Engineering Science, California Institute of Technology

Research Interest:

Flow and transport phenomena in geologic media. Use of analytical and numerical methods for the solution of problems concerning single and multi-phase flow and transport, with applications to nuclear waste disposal and petroleum recovery.

Experience Summary:

Dr. Houseworth's professional experience includes groundwater and surface water hydrology and petroleum reservoir engineering. He is currently working on DOE's nuclear waste disposal research program focusing on hydro-mechanical behavior and characterization of argillaceous rock as a lithology for disposal. He is also involved in the technology and impacts of hydraulic fracturing and other well stimulation methods for oil and gas production. Dr. Houseworth performed technical and management support for scientific investigations at Yucca Mountain, Nevada, DOE's previously proposed disposal site for high-level radioactive waste. This includes unsaturated zone flow and transport analyses in fractured rock to support performance assessment of the potential repository system and analyses to support construction and testing activities at Yucca Mountain. In addition, he has worked on characterization of petroleum reservoirs including laboratory core analysis methods to determine single and multiphase flow properties and reservoir simulation.

Professional History:

2010 to Present **Lawrence Berkeley National Laboratory** **Berkeley, California**
Program Manager

Participated in project planning and development for the DOE Used Fuel Disposition Program within the nuclear energy and waste program at Berkeley Lab. Developed an information baseline for features, events, and processes of high-level nuclear waste disposal in clay/shale repository host rock and bentonite backfill. Participated in the development of a modeling methodology for coupled thermal-hydrological-geomechanical processes include fracture damage in the excavation disturbed zone of a high-level nuclear waste repository. Participated in risk assessments and technical analyses concerning geologic sequestration of carbon dioxide. Conducted technical assessments of hydraulic fracturing and other well stimulation methods for oil and gas production.

2000 to 2010 **Lawrence Berkeley National Laboratory** **Las Vegas, Nevada**
Program Manager

Responsible for technical and budget planning, work package management, and technical interfaces (internal and external) for Unsaturated Zone Flow and Transport activities on the Yucca Mountain Project. Lead author for the license application chapter on unsaturated zone flow. Participated in interactions with the Nuclear Regulatory Commission and Nuclear Waste Technical Review Board concerning unsaturated zone flow and transport. Developed models for flow and transport in porous media and fractured rock to address fracture-matrix exchange of water and radionuclides, the effects of flow diversion around waste emplacement drifts on radionuclide transport, and radionuclide mixing in the drift invert.

1997 to 2000 **Duke Engineering and Services** **Las Vegas, Nevada**
Technical Systems Manager II

Managed unsaturated zone radionuclide transport modeling used in performance assessment for the Yucca Mountain Project. Investigated sensitivity of radionuclide transport in the unsaturated zone to fracture characteristics and participated in establishing suitable parameter ranges for unsaturated zone transport modeling. Developed a comprehensive summary analysis for all potential factors that could affect unsaturated zone processes important to repository performance.

1992 to 1997 **INTERA Inc.** **Las Vegas, Nevada**
Senior Staff Consultant

Responsible for performance assessment support of site characterization activities at Yucca Mountain, Nevada, DOE's proposed high-level nuclear waste disposal site. The site characterization activities included excavation of a twenty-five foot diameter, five-mile long tunnel through the potential repository zone, construction and operation of surface and subsurface support facilities, borehole drilling, and hydrological, geochemical, and geophysical testing. All activities were evaluated with respect to any potential adverse effects on the performance of the site as a nuclear waste repository. Controls to restrict construction and testing activities were developed as needed to limit any identified adverse effects.

1984-1992 **Chevron Oil Field Research Company** **La Habra, California**
Research Engineer

Managed numerous projects to determine flow properties of earth cores and assessed effects of geologic variability on subsurface transport processes. Project leader for technical service and research programs involving two-phase gas/liquid and liquid/liquid flow in porous media. Investigations included laboratory testing and numerical modeling to assess the effects of rock heterogeneity, fluid phase behavior and fluid mixing.

1978-1979 **Bechtel, Inc.** **San Francisco, California**
Engineer

Performed study of surface water reservoir dynamics and water quality and designed outfalls for nuclear power waste heat discharge.

Publications, Reports and Presentations:

California Council on Science and Technology, Lawrence Berkeley National Laboratory & Pacific Institute, 2014. Advanced Well Stimulation Technologies in California: An Independent Review of Scientific and Technical Information, Sacramento, CA. Available at: http://ccst.us/BLMreport.

Asahina, D., J.E. Houseworth, J.T. Birkholzer, J. Rutqvist, J. Bolander. 2014. Hydro-mechanical model for wetting/drying and fracture development in geomaterials, Computers & Geosciences, http://dx.doi.org/10.1016/j.cageo.2013.12.009.

Asahina, D., J.E. Houseworth, J.T. Birkholzer 2013. Discrete Fracture Hydromechanical Model for the Disturbed Rock Zone in a Clay Rock, AGU Fall Meeting, December 2013.

Houseworth, J.E., D. Asahina, J.T. Birkholzer. 2013. An Analytical Model for Solute Transport through a Water-Saturated Single Fracture and Permeable Rock Matrix, Water Resources Research, Vol. 49, 1–22, doi:10.1002/wrcr.20497.

Rechard, R.P., B.W. Arnold, B.A. Robinson, J.E. Houseworth. 2013. Unsaturated Flow Modeling in Performance Assessments for the Yucca Mountain Disposal System for Spent Nuclear Fuel and High-Level Radioactive Waste, Reliability Engineering and System Safety, http://dx.doi.org/10.1016/j.ress.2013.06.025i.

Rechard, R.P., B.W. Arnold, B.A. Robinson, J.E. Houseworth. 2013. Transport Modeling in Performance Assessments for the Yucca Mountain Disposal System for Spent Nuclear Fuel and High-Level Radioactive Waste, Reliability Engineering and System Safety, http://dx.doi.org/10.1016/j.ress.2013.06.031i.

Asahina, D., J. Houseworth, J. Birkholzer. 2013. Thermal-Hydro-Mechanical Modeling of Clay Rock Including Fracture Damage, International High-Level Radioactive Waste Management Conference, Albuquerque, N.M., April 28-May 2, 2013.

Blanco Martín, L., J. Rutqvist, J. Houseworth, and J. Birkholzer. 2013. THM Processes modeling to evaluate salt-based repositories in the long-term. Submitted to the *2013 International High-Level Radioactive Waste Management Conference, Albuquerque, 28 April-2 May 2013*.

Nicot, J.-P. C.M. Oldenburg, J.E. Houseworth, J.-W. Choi. 2013. "Analysis of Potential Leakage Pathways at the Cranfield, MS, U.S.A., CO_2 Sequestration Site", International Journal of Greenhouse Gas Control, Vol. 18, October 2013, pp. 388-400. http://dx.doi.org/10.1016/j.ijggc.2012.10.011.

Asahina, D., J. Houseworth, J. Birkholzer, J. Bolander. 2012. A thermo-hydro-mechanical model for fracture propagation and evolution, fluid flow, and transport in the disturbed rock zone of an argillaceous repository, Clays in Natural and Engineered Barriers for Radioactive Waste Confinement, 5th International Meeting, October 22-25, 2012, Montpellier, France.

Asahina, D., J. Houseworth, J. Birkholzer. 2012. Thermal-hydrologic-mechanical model for fracture propagation, fluid flow, and transport in porous rock, TOUGH Symposium 2012, Lawrence Berkeley National Laboratory, Berkeley, California, September 17-19, 2012.

Houseworth, J. E. and Jordan, P. D. (2012), Potential for environmental impact due to acid gas leakage from wellbores at EOR injection sites near Zama Lake, Alberta: response to D.M. LeNeveu. Greenhouse Gas Sci Technol, 2: 314–319. doi: 10.1002/ghg.1289.

Robinson, B., J. Houseworth, S. Chu. 2012. Radionuclide Transport in the Unsaturated Zone at Yucca Mountain, Nevada, Vadose Zone Journal. 2012 11:– 10.2136/vzj2011.0133.

Birkholzer, J., J. Houseworth, C-F Tsang. 2012. Geologic Disposal of High-Level Radioactive Waste—Status, Key Issues, and Trends, Annual Review of Environment and Resources, Vol 37. pp. 79-106.

Houseworth, J.E. 2012. Matched Boundary Extrapolation Solutions for CO_2 Well Injection into a Saline Aquifer, Transport in Porous Media, Volume 91, Issue 3, pp 813-831.

Zhang, Y., H.H. Liu, J. Houseworth. 2011. Modified Generalized Likelihood Uncertainty Estimation (GLUE) Methodology for Considering the Subjectivity of Likelihood Measure Selection, Journal of Hydrologic Engineering, 16(6), doi:10.1061(ASCE)HE.1943-5584.0000341.

Houseworth, J. 2011. Natural Disturbances of Argillaceous Caprock Integrity: Petroleum Analogues for Nuclear Waste Repository Systems, International High-Level Radioactive Waste Management Conference, April 10-14, 2011.

Cotte, F., C. Doughty, J. Houseworth, and J. Birkholzer, 2011. Modeling Single-Well Injection-Withdrawal (SWIW) Tests for Characterization of Complex Fracture-Matrix Systems, International High-Level Radioactive Waste Management Conference, April 10-14, 2011.

Rutqvist, J., J. Birkholzer, J. Houseworth, and H.H. Liu, 2011. Modeling of Coupled Geomechanical Processes Associated with Bentonite-Backfilled Repository Tunnels in Clay Formations, International High-Level Radioactive Waste Management Conference, April 10-14, 2011.

Houseworth, J.E., and E. Hardin, 2009. Response to "Analysis of the Treatment, by the U.S. Department of Energy, of the FEP Hydrothermal Activity in the Yucca Mountain Performance Assessment" by Yuri Dublyansky (Risk Analysis, Volume 27, Issue 6, Pages 1455–1468, December 2007). LBNL-1253E. LBNL Report, Berkeley, CA.

Houseworth, J. E. and J. Leem. 2009. A Quasilinear Model of Solute Transport under Unsaturated Flow. Vadose Zone Journal. 2009 8: 1031-1037.

Houseworth, J. E. 2006. An Analytical Model for Solute Transport in Unsaturated Flow through a Single Fracture and Porous Rock Matrix. Water Resour. Res., 42, W01416, doi:10.1029/2004WR003770.

Zhang, K., Wu, Y.S., Houseworth, J.E. 2006. Sensitivity analysis of hydrological parameters in modeling flow and transport in the unsaturated zone of Yucca Mountain, Nevada, USA. Hydrology Journal, 14, pp. 1599-1619, June 2006.

Houseworth, J. E., S. Finsterle, G.S. Bodvarsson. 2003. Flow and Transport in the Drift Shadow in a Dual Continuum Model. Journal of Contaminant Hydrology Vols. 62-63, April-May 2003, pp. 133-156.

Houseworth, J. E., G. Moridis, G. S. Bodvarsson. 2001. The Effects of the Drift Shadow on Radionuclide Transport. High Level Radioactive Waste Management, Ninth Annual International Conference, Las Vegas, Nevada.

Keller, R., N. Francis, J. E. Houseworth, N . Kramer. 2001. Impact of Drill and Blast Excavation on Repository Performance Assessment. High Level Radioactive Waste Management, Ninth Annual International Conference, Las Vegas, Nevada.

Li, C., J. E. Houseworth, B. A. Robinson. 1998. Influence of Matrix Diffusion and Adsorption on Radionuclide Transport. High Level Radioactive Waste Management. Eighth International Conference, Las Vegas, Nevada.

Houseworth, J. E., 1995. Effects of Exploratory Studies Facility Construction Water on Radionuclide Release. High Level Radioactive Waste Management, Sixth Annual International Conference, Las Vegas, Nevada.

Houseworth, J. E., 1995. A Generalized Bulk Model for Nonequlibrium Unsaturated Flow in a Fractured Porous Rock. AGU Fall Meeting, San Francisco, California

Sassani, D. C. and J. E. Houseworth, 1995. Bounding Potential Diesel Exhaust Impacts Produced from North Ramp Construction. High Level Radioactive Waste Management, Sixth Annual International Conference, Las Vegas, Nevada.

Houseworth, J. E., 1994. A Higher-Order Model for Shear Dispersion in a Saturated Fracture/Matrix System. AGU Chapman Conference on Aqueous Phase and Multiphase Transport in Fractured Rock, Burlington, Vermont.

Houseworth, J.E., 1993. Characterizing Permeability Heterogeneity in Laboratory Core Samples from Standard Miscible Displacement Experiments. Society of Petroleum Engineers Formation Evaluation, Vol. 8, No. 2, pp. 112-116.

Houseworth, J.E., 1991. Sensitivity of Large-Scale Water/Oil Displacement Behavior to Fine-Scale Permeability Heterogeneity and Relative Permeabilities. SPE 22590, SPE Annual Meeting, Dallas, Texas.

Houseworth, J.E., 1984. Longitudinal Dispersion in Nonuniform, Isotropic Porous Media, Ph.D. Thesis, W.M. Keck Laboratory of Hydraulics and Water Resources, California Institute of Technology, Report No. KH-R-45, June.

Houseworth, J.E., 1984. Shear Dispersion and Residence Time in Laminar Flow through Capillary Tubes. Journal of Fluid Mechanics, Vol. 142, pp. 289-308.

Houseworth, J.E., G.R. Cass, and P.S. McMurray (1980) Methods for Sulfate Air Quality Management, Environmental Quality Laboratory Report, R-16, California Institute of Technology, May.